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· USDA FOREST SERVICE RESEARCH NOTE

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PHELLINUS (PORIA) WEIRII ROOT ROT IN DOUGLAS-FIR-ALDER STANDS 10-17 YEARS OLD[1]

by

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ABSTRACT

Red alder growing in even-aged mixture with Douglas-fir did not reduce initial losses to *Phellinus weirii* 10- to 17-year-old Douglas-fir plantations. The ability of alder to reduce later losses from lateral spread within the stand was not examined. *P. weirii* is creating openings in these young stands with 3 percent of the trees already dead in one case. The symptoms and distinguishing features of *P. weirii* infection on young trees are described.

Keywords: Root rot, *Phellinus* (*Poria*) *weirii*, alder, Douglas-fir.

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Phellinus weirii (Murr.) Gilb. (*Poria weirii* (Murr.) Murr.), cause of a destructive root rot, attacks most western conifers including Douglas-fir, *Pseudotsuga menziesii* (Mirb.) Franco. The fungus can survive more than 50 years in infected roots and stumps, infecting roots of a new tree generation as they contact old residues (Wallis and Reynolds 1965).

The hypothesis that red alder, *Alnus rubra* Bong., alters the soil environment to the detriment of *P. weirii* has been developed through research and observation in the Northwest but needs further testing in the field. Alder, in addition to not being susceptible to *P. weirii*, produces phenolic and fatty acid compounds which are toxic to the fungus (Trappe 1972, Trappe et al. 1973) and adds nitrogen to the soil. Micro-organisms antagonistic to *P. weirii* increase and *P. weirii* survival decreases in nitrogen-amended soils (Nelson 1970). In addition, limited field data suggest that *P. weirii* damage to pole-size and larger Douglas-fir is less severe in stands mixed with alder than in pure stands (Trappe 1972).

If alder does reduce *P. weirii* damage, it could act in several ways. The presence of alder might simply result in a wider spacing of susceptible trees, resulting in fewer root contacts and less chance for spread. External mycelial growth of *P. weirii* might be prevented or slowed in a soil altered by alder. Alder root exudates or the micro-organisms they stimulate might actually penetrate wood infected by *P. weirii* and kill the pathogen.

The objective of the research described here was to determine whether alder growing in even-aged mixture with Douglas-fir influenced initial infection in a new tree generation by residual infected root systems from the preceding stand.

STUDY AREAS

Four study sites about 48 km west of Corvallis, Oregon, on the Siuslaw National Forest were examined in 1973. Each was a Douglas-fir plantation with a naturally seeded admixture of red alder. The sites had been planted immediately after harvest of mature Douglas-fir stands 10-17 years before examination. Growth ring counts indicated that natural alder had seeded within 1 or 2 years after harvest in each case. The plantations were on north, east, and west aspects and typified by abundance of *P. weirii* root rot, steep slopes, and thick brush. Although three of the plantations had been sprayed with herbicides, the alder was as tall as or taller than the fir and vigorous at the time of examination. Alder in the fourth plantation had been thinned in 1972.

PROCEDURE

Distances from *P. weirii*-infected Douglas-fir and healthy Douglas-fir to alder trees were recorded during field examinations. All trees, living and dead, on a 3.6 ha area of the first plantation (3504-11, table 1) were examined for root infection. *P. weirii* was confirmed as the cause of death or distress on all symptomatic trees by examination of the root collar for characteristic mycelium. Age and height of each infected tree were recorded, together with the distance to each alder within a radius equal to the height of the infected tree. A separate 10-percent sampling using 0.008 ha circular plots on a rectangular grid was conducted for information on the total stand. For each healthy Douglas-fir within a plot, the distance to each alder within a radius equal to the tree's height was recorded.

The other three plantations were sampled along meandering transects following the slope contour, rather

Table 1.--*Proximity of* Poria weirii-*killed and healthy Douglas-fir to red alder in 4 plantations*

Plantation		Infected trees examined	Infected Douglas-fir with alder at distance of:		Healthy Douglas-fir with alder at distance of:	
Number[1/]	Age		< 5 feet	< tree height	< 5 feet	< tree height
	Years	- - Number - -	- - - - - - - - - - - - -	Percent	- - - - - - - - - - - - -	
1. (3504-11)	12	79	7	31	6	26
2. (3406-22)	10	54	43	57	45	58
3. (3501-24)	17	34	9	35	4	39
4. (3504-3, 4, 71)	12	39	2	26	2	18
Average	13	--	15	38	10	33

[1/] Alsea Ranger District, Siuslaw National Forest code.

than on an area basis. Data on *P. weirii*-infected trees along the transects were gathered as before, and healthy stand information was again based on 0.008 ha plots. A plot was located 10 m along the contour from each *P. weirii*-infected tree or group of trees, and the distances to alders recorded as before.

RESULTS

Table 1 summarizes the information on the four stands. Overall, proximity to alder did not reduce the chances for *P. weirii* infection of Douglas-fir. Of the infected trees, 38 percent had an alder growing within a distance equal to their height, compared with 33 percent of all healthy Douglas-fir trees sampled. The same situation was evident when only red alder growing within 1.52 m of fir trees were considered.

The aboveground indications of *P. weirii* infection included reduced terminal growth and often a bent leader, yellowish to red foliage, and occasionally a "distress" cone crop. Reduced height growth of infected trees started 1 to 3 years before death and was often evident before foliage discoloration.

The crown symptoms are not unique to *P. weirii* infection but indicate trouble of some sort below. This may be nutrient deficiency, girdling by rodents or bears, or attack by any of several root disease organisms. *P. weirii* was easily confirmed in these young trees by examination of the root collar region for the distinctive mycelium. *P. weirii* grows on root surfaces, and scraping the duff layer away revealed the tawny white fungal hyphae covering the roots and often binding soil particles to the roots. Thin brown hyphal crusts were found on some roots. Examination of these roots with a 10× hand magnifier revealed scattered, brown, specialized hyphae called setae. These were much larger than the rest of the hyphae and were positive confirmation of *P. weirii*.

In the plantations examined, 206 of 211 dead or dying trees had *P. weirii* mycelium at the root collar. Three were killed by *Verticicladiella* sp., and two were girdled by rodents.

P. weirii has already created numerous openings in these plantations. Plantation 1, with 810 trees/ha after thinning, had lost 22.8 trees/ha to *P. weirii*. Of these, an average of 8.3 trees/ha (about 1 percent of the stand) first showed *P. weirii* symptoms in the year after thinning. Of the 81 dead or dying trees in this 3.6 ha plantation, 65 occurred in 20 small infection centers on 2 or more trees each. Although the survey technique used in the other three plantations did not allow expression of results on a tree/ha basis, they appeared to be even more severely damaged than the first.

DISCUSSION

Red alder has not reduced losses to *P. weirii* in these plantations at this stage in stand development. In many cases, especially in plantation 2, *P. weirii* had infected trees growing in the midst of alder clumps, but a *P. weirii*-infected stump from the previous stand was usually within a few feet of the dead tree. Most of the infection of Douglas-fir in these young stands has presumably resulted from root contact with infected roots left from the previous stand, not from root-to-root spread within the current generation.

The failure of alder in even-aged mixture with Douglas-fir to prevent these initial infections from residual material is not surprising, considering the extreme hazard and the short period of time for soil modification. The ability of alder to reduce lateral spread of *P. weirii* within a stand was not tested in this study. The effects of longer periods of plantation mixtures, as well as crop rotation with alder, must be examined before the full potential of red alder as a disease control agent is known.

P. weirii caused nearly all of the mortality found in this study, but elsewhere other pathogens may be encountered more frequently. Two common fungi are easily distinguished from *P. weirii*. *Armillaria mellea* forms a mycelial "fan," or mat of hyphae beneath the bark, not on the root surface, and often causes considerable resin flow at the butt of a tree. *Verticicladiella,* on the other hand, forms no visible mycelium, but cross-sections of infected roots show crescents of brown-black stain. Other fungi may form surface mycelium on roots and the root collar, but these are usually pure white or yellowish, not white with reddish-brown tones like *P. weirii*.

Initial infection of young trees from residual inoculum results in scattered mortality over the area of an old infection center. This may at first appear to be a beneficial natural thinning, and even a 1-percent annual mortality rate would not leave an understocked stand at maturity if the right trees died. Because it spreads from tree to tree over root contacts, however, *P. weirii* mortality results in slowly enlarging, nonstocked holes in the stand.

There are possibilities for controlling *P. weirii* by planting less susceptible species or removing the inoculum, if the problem is recognized at harvest time. If the problem is not recognized until after a new stand is established, fiscal losses can be reduced by recognizing infection centers and avoiding costly operations such as interplanting or precommercial thinning in their vicinity. Although trees can be attacked and killed whenever their roots contact inoculum, mortality may not be evident in a stand for as long as 10 years after planting.

If the final report on plantation establishment is 10 years or more after planting, an assessment of future losses is possible and silvicultural treatments can be planned accordingly.

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